Emotional Self-Awareness System for Mental Health

(SAMBEDS – Lifestyle management model for depression and anxiety)

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Abstract— **A considerable proportion of the human population experience a form of mental health disorder but estimated are about 350 million people suffering from depression according to the World Health Organisation. Now considered one of the leading health conditions, depression contributes significantly to the recorded health-related work absences in the western world. Although mental health associated issues exacerbate for various shortcomings, practitioners and patients have been exploring different methods to conquer this exacerbating circumstance. A notable potent strategy in recent times is the adoption of lifestyle management through emotional self-awareness. While the concept of emotional self-awareness is linked to emotional intelligence, accomplishing a hallmark of realistic self-assessment can be challenging for the potential difficulty of comprehension (i.e., signs and symptoms may be ambiguous or incorrectly comprehended), which may cause misdiagnosis and maltreatment. This work acknowledges the surge in eHealth and presents SAMBEDS emotional self-aware model for managing anxiety and depression through lifestyle management. Thirty-four lived experience candidates participated in the co-created emotional self-aware system prototype, which considers lifestyle factors for managing depression and anxiety. We adopted quantitative and qualitative methods (questionnaires, informal and formal feedback sessions) to co-create the system requirements, design and evaluation. Besides, the user experience study conducted appraises the user activities using a 360-degree camera and eye-tracking device. Although only 50% of the service users are depression and anxiety diagnosed candidates, 70% of the overall participants (including other types of diagnoses) showed high fulfilment in terms of design, usability and efficacy of the for managing system mental health conditions.**

Keywords- emotional intelligence; emotional self-awareness; lifestyle changes; mHeath; Software as a Medical Device (SaMD); eHealth; mental health systems; diagnosis; prevention; alleviation; SAMBEDS.

I. INTRODUCTION

Mental Health is defined as a state of wellbeing by which an individual can cope with the normal stress of life, recognises own abilities, work productively and contribute to own society [1]. While many authors subscribe to distinctive definitions, the lack of a consensus definition is attributed to the differences in values, cultural and social backgrounds among other attributes, although the notion of mental health not being solely the absence of mental illnesses is consented by most authors [2]. Therefore, a less-restrictive or cultural-bound definition that accommodates emotional state variation and imperfect functioning is promoted. Consequently, factors including the dynamic state of internal equilibrium, cognitive and social skills, empathy, flexibility to cope, harmonious body-mind relationship, and emotional regulation are prescribed [2].

Nowadays, depression increasingly becomes a popular mental health condition, which about 300 million people suffer globally [3]. Not only is it considered one of the leading condition responsible for health-related work absences in the western world, but a UK study also showed 595,000 cases of workers suffered from depression, stress and anxiety between 2017 and 2018. A recent Labour Force Survey (LFS) in a similar period revealed 15.4 million workdays (57.3% of total days lost to ill-health) was lost to mental health-related issues [4]. Furthermore, 43.4 million adults (17.9%) were estimated to suffer a form of mental illness in 2015 in the United States [5].

Although various alleviation procedures are being proposed, a significant proportion of mentally ill candidates yet lack appropriate interventions or supports. Factors hindering such support range from a shortage of medical practitioners particularly, psychiatrists in rural areas [6], the lack of progress monitoring tools, and deficit in mental health budgets - for instance, 78.9% of African countries spend less than 1% and only 54% of European countries spend over 5% of their health budgets on mental health [7] - among other factors.

Beyond these limitations, stakeholders are now taking different turns to improve this escalating health condition. One of such shifts is alleviation through self-monitoring of thoughts and behavioural activities to improve depressive symptoms [8]. Subsequently, self-monitoring is a concept of self-awareness, which is one of the five major components (including self-regulation, empathy, motivation, social skill) of emotional intelligence. Its major hallmark of realistic self-assessments harmonises the capacity to recognise one's moods, emotions, strengths, weaknesses, drives, values, and goals and their corresponding impacts [9]. A realistic assessment will not only help understand one's emotional state and imperfect functions but can help adopt an appropriate lifestyle for any realised imperfect functioning.

Nonetheless, achieving a realistic assessment (i.e., the management of own emotional awareness) can be a challenge without appropriate support and adequate guiding

tools. For instance, without a rigorously tested tool, how do individuals measure corresponding lifestyle activities in relations to their emotions? Yet, the advances in technology incorporate innovations such as automation even with further investments. For instance, the mHealth industry is expected to hit a hundred billion dollars by 2025 thus, these challenges are becoming surmountable. Nowadays, more individuals own a smartphone and are likely to use established apps to monitor changes in their lifestyle activities including physical and diet than those without a smartphone [10]. In additions, users have been seeking interventions through apps in recent times. For instance, the Kooth counselling app - an online counselling and wellbeing platform - where many teens turn to seek support with mental health issues has recorded a surge in recent years [11]. Considering the increasing access to technology, which brews the surge in the adoption of Software as a Medical Device (SaMD) and medical apps, this work proposes SAMBEDS model, a co-created depression and anxiety management system based on the Framework for Lifestyle Management pro Mental Health, FLMMHS [12].

The rest of the paper is structured as follows; Section II discusses the methodology involving co-creation and data analysis techniques; Section III describes the development of SAMBEDS model-based system, an emotional self-aware system for anxiety and depression; Section IV presents the evaluation and results of the system, while conclusions and future work were manifested in Section V.

II.   METHODOLOGY AND DATA ANALYSIS

Taking that a single method may not cover all areas of research and system development, we adopted mixed methods involving techniques of qualitative, quantitative and engineering approaches. Although the system development emulates the Framework for Lifestyle Management pro Mental Health Systems (FLMMHS) [12], which the concept of Diagnosis, Prevention and Alleviation (DPA) is preeminent, we utilised a co-creation strategy to develop an effective emotional self-aware system. Adopting mixed methods will not only support the understanding of areas uncovered by a singular method [13], it also allows a provision of suitable coverage for any discovered aspects. Therefore, we utilised techniques including questionnaire surveys, prototyping and interviewing and feedback following a co-creation approach.

A.   Co-creating emotional self-aware elements

Although FLHMMS framework emphasises lifestyle management approach for mental health oversight, the procedures of diagnosis, prevention and alleviation adopt digital tools to manage the associated lifestyle factors of the intended mental health disorder. Hence, this work utilises a document analysis technique to establish corresponding lifestyle elements necessary for emotional self-awareness in managing depression and anxiety.

B.   SAMBEDS derivation and Document Analysis

Similar to other qualitative methods, document analysis allows the review of specific field data and perhaps, develop empirical knowledge from the examined documents or data [14]. Hence, this work examines published data about anxiety and depression from different publication platforms including IEEE Library, NCBI/PubMed (National Center for Biotechnology Information), American Journal of Psychiatry and BMC Public Health among others. Then, we utilised the examined information imperatively for the derivation of the system knowledge and its design and development. For instance, monitoring mood changes and its corresponding symptoms are rarely monitored outside a clinical setting, but such information could help improve clinical care and intervention [15]. Also, a study by Robertson et al, indicated walking can improve symptoms of depression [16], but Meyer and Broocks concluded that a good amount of aerobics exercises will improve mood against depression [17]. In terms of behaviour and thought, not only can note-taking help to enhance the decluttering of the mind, but patterns identified through the logs of negative thoughts and feelings can be enhanced through emotional self-awareness. Similarly, sleep quality has been highlighted to contribute to depressive symptoms [18]. While low vitamin D level is identified to be associated with depression and anxiety [19], a reduced blood flow of key stress-reducing hormones is also linked to dehydration [20].

Based on the different established findings, this work devises a seven lifestyle factors, SAMBEDS to enhance emotional self-awareness for mental health management. Highlighted SAMBED factors include *"Sleep Pattern"*, *"Activity and Social"*, *"Mood Change"*, *"Behaviour and Thought"*, *"Exercise and Fitness"*, *"Diet and Hydration"*, and *"Spiritual and Meditation"*. We further examined these seven core elements as an area of emotional self-awareness for mental health in the data collection section.

C.   Data collection

In addition to the document analysis exercise that establishes relative emotional self-awareness factors of mental health disorder, the derived survey questions were also validated by service users in interactive sections. Thirty-four lived experience candidates were randomly selected and the nature of their disorders were established based on the eight-point question survey as shown in Table I.

TABLE I. QUESTIONS TO EVALUATE CANDIDATES' UNDERSTANDING OF CURRENT SUPPORT SYSTEM

No	Questions
1	Have you ever been diagnosed with any mental health conditions?
2	If Yes, what kind of support do you receive?
3	Do you get support immediately available when you need it?
4	Generally, rank the order of importance of keeping track and monitoring the following in relation to mental health: mood, sleep, social activities, thought/behavior, diet, exercise, spiritual/meditation.

5	Chose the three activities that you consider most relevant to you (manage own life, seek professional advice, be in control own life, keep diary, prefer face-2-face contact, dislike discussing own mental health and prefer to find own solution).
6	Do you feel regular self-monitoring of your lifestyle will enhance mental health and general wellbeing?
7	Do you ever or currently use any healthcare management app or SaMD?
8	What is your opinion on the current mental health care system?

An indication of mental health cases and corresponding percentages of service users are as shown in Table II.

TABLE II.   MENTAL HEALTH DISORDER AND CORRESPONDING CASES

Mental Health Disorder	No of cases	Percentage of cases (%)
Depression	22	64.7
Anxiety	22	64.7
Substance use Disorder	1	2.9
Stress-related Disorder	6	17.6
Bipolar Disorder	1	2.9
Post-traumatic stress Disorder	1	2.9
Schizophrenia	1	2.9
Don't want to disclose	1	2.9

Table II reveals that in more than a singular case, a candidate may have been diagnosed with more than one disorder. We recorded fifty-five diagnosed disorder cases from the thirty-four participating service users. Emphatically, we expect that the survey questions will thoroughly establish the participants' perception of the current mental health system particularly, how the existing mental health system supports their conditions, i.e., in terms of usability, expectations and efficacy. The survey questions are further explained in the following section, survey questions explained.

1) Survey questions explained: While the survey proposes to validate the defined seven core elements of emotional self-awareness for mental health management, the impacts of the questions vary in diverse perspectives. While the first question aims to establish the candidates' type of diagnosis as highlighted in Table I, we establish the nature of support they received and the immediate frequency of getting these supports with second and third questions, respectively. Although question four confirms the significance level of these core elements, question five identifies the participants' preferred approach for dealing with their associated mental health conditions. Questions six measures the respondents' perception of the concepts of

emotional self-awareness to manage mental health and general wellbeing. Subsequently, questions seven and eight examine the participants' ability to use health devices and their opinions on the existing methods of dealing with mental health, respectively. The results of questions conjoining with the formal feedback exercise effectively aid the development of an "emotional-awareness" system for depression and anxiety. The survey results were further elaborated in the survey result section as follows.

2) Survey results explained: Regarding the supports received by candidates, only about 35% of the participants responded to this question. While these candidates may have received varied support types perhaps, on multiple occasions, at about 75% of these occasions were these supports provided by families and friends as shown in Figure 1. Conversely, 41.7% of each occasion were candidates seeking to manage the situation by themselves or go for therapy or other medical options. Interestingly, none of the participants has chosen not to have had any form of support perhaps, such situations may not have arisen in cases of mild mental health situations. However, it is particularly unsurprising that a significant proportion of candidates do not get immediate support when needed; only 29% of the candidates get immediate support while 71% do not, hence an explanation the rapid mental health cases recorded in recent times. Ranking the order of importance of SAMBEDS elements by the participants reveals behavioural and thought element as the most important.
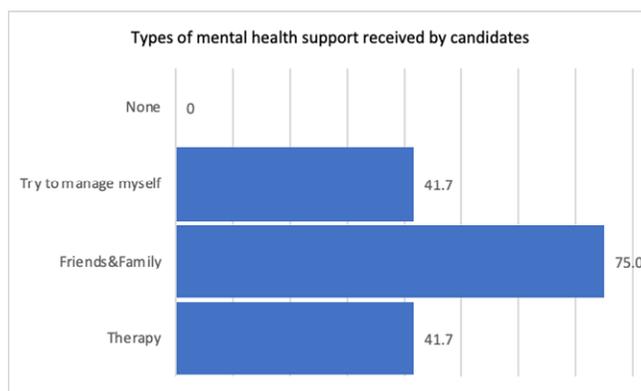

Figure 1. Percentage (%) of candidate and types of support received.

Followed in the order of importance are *sleep pattern*, *mood change*, *spiritual/meditation* and *activity/social*, respectively. Bottom ranked elements are *diet/hydration* and *exercise/fitness* with the same rating score. However, considering that the ranking of these elements is perceptual, it is interesting to note all elements recorded same overall rating value (68%) except for *sleep pattern* (70%) and *mood changes* (84%) which are slightly ranked higher, respectively (see Figure 2). Not only does this evidence the importance of these identified elements in mental health

management, but it also exhibits mood changes as a very important self-aware element in managing depression and anxiety.
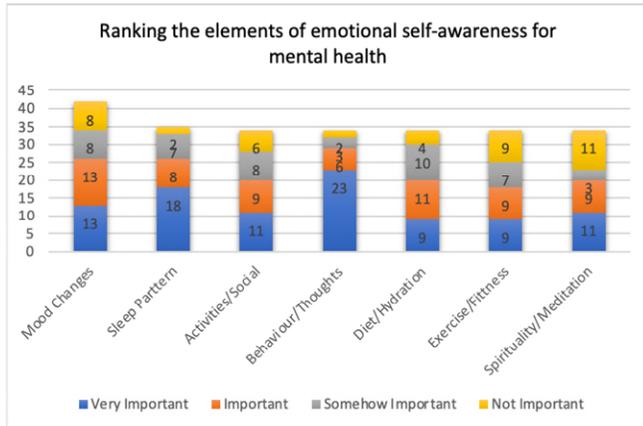

Figure 2. Ranking (n) the importance of emotional self-aware elements.

Not only do the participation of lived-experienced candidates better reflect the preferred approaches of managing mental health situations, but also provides a depth understanding of preeminent options habitually adopted by mental health candidates. For instance, as shown in Figure 3, a significant proportion of the candidates prefer to manage their own life, preferred a face-to-face conversation and perhaps, be in control of things by themselves. Not only does this result evidence own freedom characteristics of humans as a requirement of any mental health management system, but it also explains the reluctance of mental health candidates in seeking professional supports.
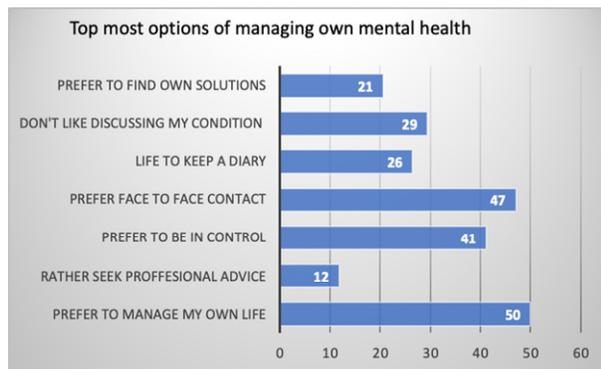

Figure 3. Participants rating the topmost options in numbers for managing mental health.

Trailing behind are options of candidates preferring not to discuss own disorder or conditions but will keep a diary or prefer finding own solutions. It is bolstering that most candidates are averse to seeking professional advice, yet this negatively correlates the reality of candidates' willing to manage their own life and being in control of their life. However, a significant proportion of candidates feel self-monitoring of their emotions 'will' or 'maybe' help improve mental health conditions. Contrary to the 88% who believe emotional self-monitoring could improve mental health

symptoms (see Figure 4), only 24% have ever used health apps or any forms of Software as a Medical Device, SaMD.
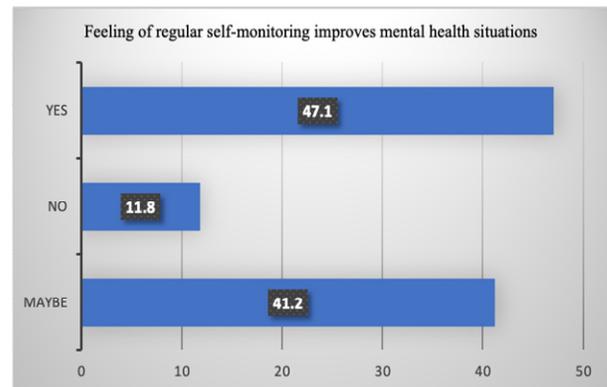

Figure 4. Rating in percentages (%) of a feel of regular self-monitoring improves mental health

Finally, participants were able to provide free-text answers to question 8 by presenting their overall perception of the current mental health system. Interestingly, some of the responses include "*pills are not the answer*"; "*dislike going into therapy*"; "*more investments in providing therapy and being able to see doctors within a day instead, of having 4-8 weeks wait*"; "*more individual and group supports*"; *feeling of therapist not being interested in users' problems*"; "*keeping track of thoughts, activities and mood swings will help to better understanding what bothers candidates*" among other comments. While these comments provided further justification for the results of the preceding questions, they also create opportunities to analyse the limitations of the existing mental health system. Not only do these results aid the derivation of robust requirements but also promote an avenue for the co-creation of an effective SAMBEDS model-based emotional self-awareness system, as discussed in the development section as follows.

III.   DEVELOPING SAMBEDS BASED SYSTEM TO MANAGE ANXIETY AND DEPRESSION

While a User-Centered-Design, UCD approach is adopted for the system development, the results derived from survey aids the specified requirements of SAMBEDS emotional self-awareness system for mental health. The system is partitioned into multiple segments to manage different activities including *mood assessment*, *progress check*, *therapist support*, *general information*, *exercise, diet, sleep pattern* and *journal* as shown in Figure 5. It is important to note that the DPA aspect of FLHMMS framework is covered in a different partition of the system. While the diagnosis component is accomplished via the mood assessment section, i.e., "*assess yourself*", users are able to rate their feelings at intervals using a corresponding smiley (very happy, happy, indifferent, sad and very sad).
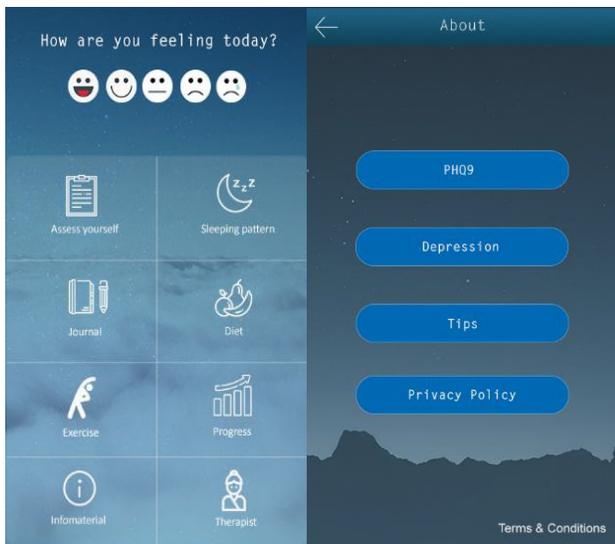
Figure 5. SAMBEDS-based system - Home and About screen.

Furthermore, a PHQ9 instrument was adopted to measure severity due to its concise diagnostic criteria for depression [21] and perhaps, its accuracy when compared to the Beck Depression Inventory, which tends to assign higher scores for severity [22]. Besides, prevention and alleviation processes were based on lifestyle changes with the intention of mood upliftment through these changes. For instance, understanding the correlation of recorded sleep patterns with other lifestyle factors are made easy through suitable life entities association such as family, health, school and studies among others via the journal (see Figure 6).

Figure 6. SAMBEDS-based system - Screens for Sleep and Journal
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In additions are the *progress* screen, which presents a graphical representation of individual progress of the SAMBEDS elements. While the *Stats* page as shown in figure 7 provides statistical awareness about the SAMBEDS elements, the therapist page allows connection with a setup therapist. Hence, users can easily share their lifestyle

records and in real-time with therapists to get appropriate advice or treatment (see Figure 7). Not only has the co-creation approach helps with an understanding of the system requirements, but it also influences the development of a usable system for the intended users. The following section discusses the results of user experience study conducted for the developed system.

Figure 7. SAMBEDS-based system - Stats and therapist screen.

IV. RESULTS AND EVALUATION

Besides the survey and interview exercises by lived-experienced candidates, a usability study was conducted in a usability lab using the eye-tracking device and a 360-degree camera to understand the impact of the system in aiding emotional self-awareness for mental health conditions. We adopted a five-factor usability approach including learnability, memorability, errors, satisfaction and efficiency [23] with a rank scale questionnaire. The rank scale ranges from 1 to 7, with 1 being the lowest and 7 being the highest rating value. We aggregated and evaluated the users' results, laying emphasis on the aforementioned five factors.

TABLE III. LIST OF USABILITY TASKS WITH TARGET TIME AND OBJECTIVES

Task No	Task Description	No of Screens	Time (S)	System Objective
1	Navigate to the registration page	3	20	Efficiency
2	Take the assessment, return score	4	20	Memorability
3	Click mood and go to Journal	2	10	Efficiency
4	Go to	2	20	Memorability

	exercise screen, click goal and go back to home screen			
5	Access PHQ9 and return to information screen	2	10	Learnability
6	Check progress	1	10	Learnability
7	Check sleep hours	2	20	Efficiency
8	Contact therapist and read advice	1	10	Efficiency

Figure 8 shows the ease of completing all activities as highlighted in Table III. Specifically, 50% of the participants give the highest rate value, 7 for interface simplicity, while 40% rate with value 6, therefore, 90% of participants consider the interface to be simple enough for emotional self-awareness.
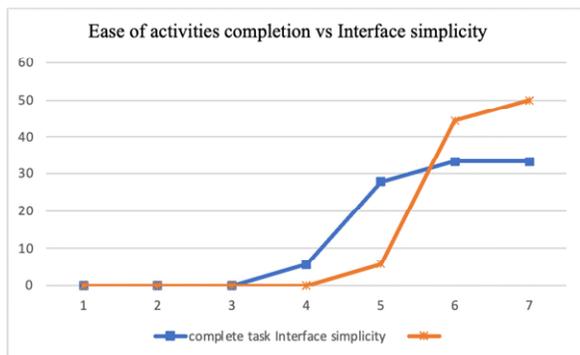

Figure 8. Perceived simplicity of interface versus ease of completion.

Also, 66.6% of participants rated the ease of completing as high, i.e., 33.3% rated value 7 and value 6 (33%). While the ease of completion only recorded an instance (5.6%) of value 4 with no instance recorded below 4 for simplicity.
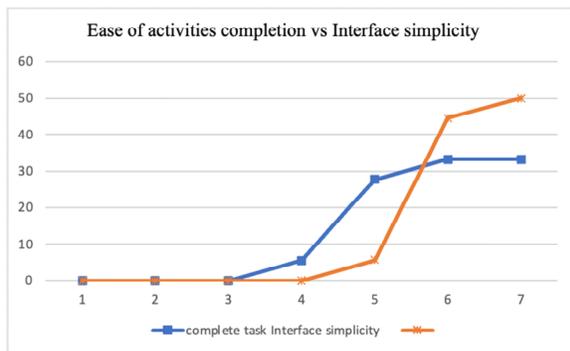

Figure 9. The ease of access to information versus learnability.

Additionally, the ease of accessing information and learnability were evaluated as shown in figure 9. A total of 83% of users rated the high values, i.e., 50% and 33.3% of users rated the learnability of system 7 and 6, respectively. Similarly, 77.8% of users rated the access to all information with the high values within the targeted time (i.e., 38.9% each rated the values 7 and 6).
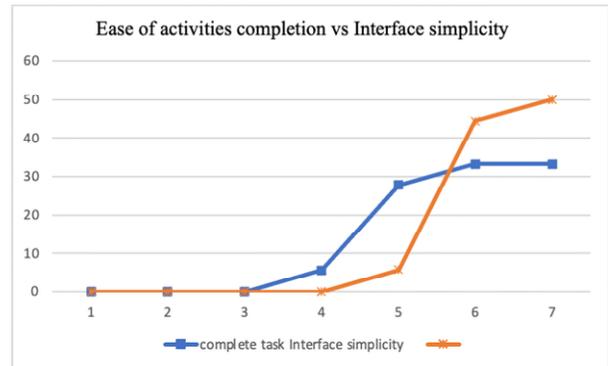

Figure 10. Overall users' satisfaction versus difficulty in navigation.

Besides, the difficulty in navigation and overall satisfaction evaluated indicated 77.8% of the participants perceived the difficulty in navigation (values 1 and 2) very low (as shown in Figure 10), thus, participants find the system easy to use in accomplishing self-awareness for mental health. Also, the recorded rating for the overall satisfaction appears between the values between 5 and 7, i.e., all the service users (100%) were highly satisfied with the system for the accomplishment of emotional self-awareness for mental health. Finally, the participants' comments strengthen the satisfaction recorded on the system. These comments include "*motivating, easy navigation, appealing layout and interactive mood monitoring*"; "*the included PHQ9 is a really good idea*"; "*icons are very useful and appealing*"; "*colour scheme is appealing, gave no eye strain*"; "*clear design balanced with image, interface clean, calming and relaxing*"; "*sharing progress with a therapist*" among other comments. Not only do these comments validate the quantitative results, but they open further research on the efficacy of SAMBEDS as emotion self-awareness tool for mental health management.

V.   CONCLUSION AND FUTURE WORK

Lifestyle factors including diet and exercise among other factors have been found to improve the quality of life and depression particularly, in overweight people. Also, a strong association has been established between improved mood and exercising. Similarly, a robust correlation between exercises and sleep has been noted in lifestyle psychiatry. This work presents a SAMBEDS model for emotional self-awareness in depression and anxiety management with seven core lifestyle elements. While a co-creation of a prototype system allows a true evaluation of these elements, all elements were considered equally important except for sleep patterns and mood changes, elements which are considered slightly more eminent. Independently, the behavioural and

thought element is rated the highest among other SAMBEDS elements, but adequate management of all elements prove contributory to emotional self-awareness in relations to mental health states. While a limitation of the system is the digital characterisation of most activities, a mitigation approach is the contraction of users' interactivity through automation. Future work must devise automatic means of extracting these core lifestyle data with minimal or no hindrance to the users' daily activities. A further interesting research challenge is the development of automatic behavioural and thoughts algorithms that will synchronise mental health state with mood changes, exercises and sleep and other SAMBEDS elements.

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